Exhibit 10

Exhibit 10
Claim 7 of U.S. Patent No. 10,447,450

U.S. Patent No. 10,447,450: Claim 7(a)

"7. A mobile device in a wireless packet system using a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the mobile device configured to"

7. A mobile device in a wireless packet system using a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the mobile device configured to:

Toyota's Accused Products include vehicles equipped with components and/or devices that enable connectivity to 4G/LTE networks and services, including services sold and provided by Toyota.

To the extent the preamble is considered a limitation, Toyota's Accused Products meet the preamble of the '450 patent. *E.g.,*

A release 8 compliant Long Term Evolution (LTE) user equipment (UE) uses a frame structure that is 10 ms long with ten subframes, time intervals, of 1 ms long each. Each subframe includes two slots.

5 Physical Layer for E-UTRA

Downlink and uplink transmissions are organized into radio frames with 10 ms duration. Two radio frame structures are supported:

- Type 1, applicable to FDD,
- Type 2, applicable to TDD.

Frame structure Type 1 is illustrated in Figure 5.1-1. Each 10 ms radio frame is divided into ten equally sized sub-frames. Each sub-frame consists of two equally sized slots. For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain.

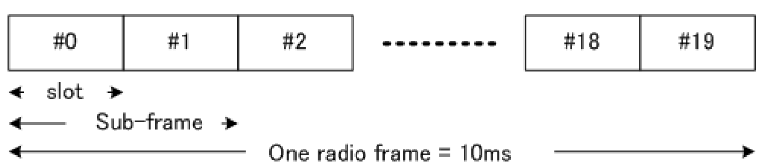


Figure 5.1-1: Frame structure type 1

Frame structure Type 2 is illustrated in Figure 5.1-2. Each 10 ms radio frame consists of two half-frames of 5 ms each. Each half-frame consists of eight slots of length 0.5 ms and three special fields: DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is configurable subject to the total length of DwPTS, GP and UpPTS being equal to 1ms. Both 5ms and 10ms switch-point periodicity are supported. Subframe 1 in all configurations and subframe 6 in configuration with 5ms switch-point periodicity consist of DwPTS, GP and UpPTS. Subframe 6 in configuration with 10ms switch-point periodicity consists of DwPTS only. All other subframes consist of two equally sized slots.

For TDD, GP is reserved for downlink to uplink transition. Other Subframes/Fields are assigned for either downlink or uplink transmission. Uplink and downlink transmissions are separated in the time domain.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 23.

The LTE downlink uses orthogonal frequency division multiplexing (OFDM). During a subframe, multiple OFDM symbols are transmitted.

5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6)

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

A subframe contains two slots, and in each slot multiple OFDM symbols are transmitted. Each symbol includes a plurality of subcarriers.

6.2 Slot structure and physical resource elements

6.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{RB}^{DL} N_{sc}^{RB}$ subcarriers and N_{symb}^{DL} OFDM symbols. The resource grid structure is illustrated in Figure 6.2.2-1. The quantity N_{RB}^{DL} depends on the downlink transmission bandwidth configured in the cell and shall fulfil

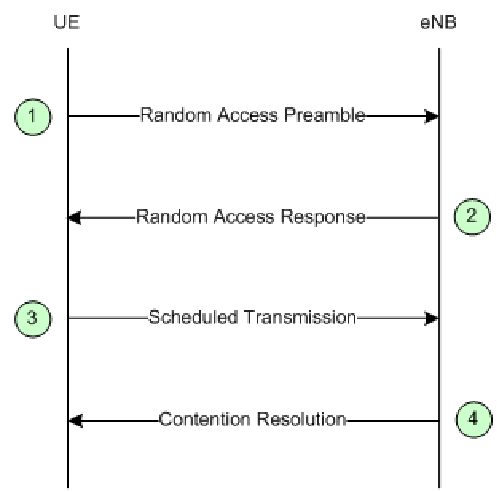
$$N_{RB}^{min,DL} \le N_{RB}^{DL} \le N_{RB}^{max,DL}$$

where $N_{RB}^{min,DL} = 6$ and $N_{RB}^{max,DL} = 110$ are the smallest and largest downlink bandwidth, respectively, supported by the current version of this specification.

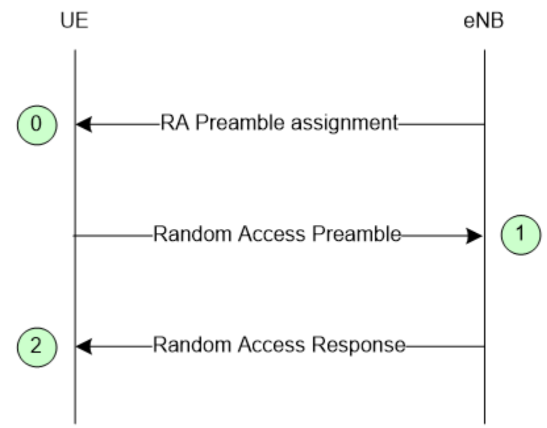
"7. A mobile device in a wireless packet system using a frame structure of multiple frames for transmission, each frame comprising a plurality of time intervals, each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and each OFDM symbol containing a plurality of frequency subcarriers, the mobile device configured to"

	See e.g., 3GPP TS 36.211 V8.9.0 at pg. 45.

"receive an identifier from a base station in a cell in which the mobile device is operating; and"

receive an identifier from a base station in a cell in which the mobile device is operating; and	Toyota's Accused Products receive an identifier from a base station in a cell in which the mobile device is operating. *E.g.*, The UE receives a cell radio network temporary identifier (C-RNTI) from an eNodeB, LTE base station. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: 1) Random Access Preamble on RACH in uplink: … 2) Random Access Response generated by MAC on DL-SCH: … - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); … 3) First scheduled UL transmission on UL-SCH: … 4) Contention Resolution on DL: … - Addressed to: - The Temporary C-RNTI on PDCCH for initial access and after radio link failure; - The C-RNTI on PDCCH for UE in RRC_CONNECTED; … The Temporary C-RNTI is promoted to C-RNTI for a UE which detects RA success and does not already have a C-RNTI; it is dropped by others. A UE which detects RA success and already has a C-RNTI, resumes using its C-RNTI.

"receive an identifier from a base station in a cell in which the mobile device is operating; and"

	See e.g., 3GPP TS 36.300 V8.12.0 at pg. 52-53. 10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

	0) Random Access Preamble assignment via dedicated signalling in DL: - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH). - Signalled via: - HO command generated by target eNB and sent via source eNB for handover; - PDCCH in case of DL data arrival. 1) Random Access Preamble on RACH in uplink: - UE transmits the assigned non-contention Random Access Preamble. 2) Random Access Response on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least: - Timing Alignment information and initial UL grant for handover; - Timing Alignment information for DL data arrival; - RA-preamble identifier. - Intended for one or multiple UEs in one DL-SCH message. *See e.g.*, 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55. The C-RNTI is an identifier used to identify the UE at the cell level. **8.1 E-UTRAN related UE identities** The following E-UTRAN related UE identities are used at cell level: - C-RNTI: unique identification used for identifying RRC Connection and scheduling; *See e.g.*, 3GPP TS 36.300 V8.12.0 at pg. 39.

<table>
<tr>
<td>receive a signal containing information from the base station over a segment of time-frequency resource,</td>
<td>
Toyota’s Accused Products receive a signal containing information from the base station over a segment of time-frequency resource. E.g.,
Resource information is sent from the base station to the UE over a physical downlink control channel (PDCCH).
…
The physical channels of E-UTRA are:
…
Physical downlink control channel (PDCCH)
- Informs the UE about the resource allocation of PCH and DL-SCH, and Hybrid ARQ information related to DL-SCH;
- Carries the uplink scheduling grant.
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 24.
The PDCCH carries downlink control information (DCI), a control message.
<h2>4.2 Downlink</h2>
Table 4.2-1 specifies the mapping of the downlink transport channels to their corresponding physical channels. Table 4.2-2 specifies the mapping of the downlink control channel information to its corresponding physical channel.
…
Table 4.2-2
<table>
<tr><th>Control information</th><th>Physical Channel</th></tr>
<tr><td>CFI</td><td>PCFICH</td></tr>
<tr><td>HI</td><td>PHICH</td></tr>
<tr><td>DCI</td><td>PDCCH</td></tr>
</table>
See e.g., 3GPP TS 36.212 V8.8.0 at pg. 8.
<h2>5.3.3 Downlink control information</h2>
A DCI transports downlink or uplink scheduling information, or uplink power control commands for one RNTI. The RNTI is implicitly encoded in the CRC.
</td>
</tr>
</table>

"receive a signal containing information from the base station over a segment of time-frequency resource,"

	See e.g., 3GPP TS 36.212 V8.8.0 at pg. 43. The PDCCH is received over the first *n* OFDM symbols, wherein $n \leq 4$. A PDCCH is formed by an aggregation of control channel elements (CCEs). Each CCE consists of a set of resource elements. **5.1.3 Physical downlink control channel** The downlink control signalling (PDCCH) is located in the first n OFDM symbols where $n \leq 4$ and consists of: - Transport format and resource allocation related to DL-SCH and PCH, and hybrid ARQ information related to DL-SCH; - Transport format, resource allocation, and hybrid-ARQ information related to UL-SCH; Transmission of control signalling from these groups is mutually independent. Multiple physical downlink control channels are supported and a UE monitors a set of control channels. Control channels are formed by aggregation of control channel elements, each control channel element consisting of a set of resource elements. Different code rates for the control channels are realized by aggregating different numbers of control channel elements. *See e.g.*, 3GPP TS 36.300 V8.12.0 at pg. 26. Resource elements make up a resource grid that defines a resource block that is transmitted during a slot, each resource element being uniquely identifiable by an index pair (*k*, *l*). **6.2.2 Resource elements** Each element in the resource grid for antenna port p is called a resource element and is uniquely identified by the index pair (k,l) in a slot where $k = 0,...,N_{RB}^{DL}N_{sc}^{RB}-1$ and $l = 0,...,N_{symb}^{DL}-1$ are the indices in the frequency and time domains, respectively. Resource element (k,l) on antenna port p corresponds to the complex value $a_{k,l}^{(p)}$. When there is no risk for confusion, or no particular antenna port is specified, the index p may be dropped.

"receive a signal containing information from the base station over a segment of time-frequency resource,"

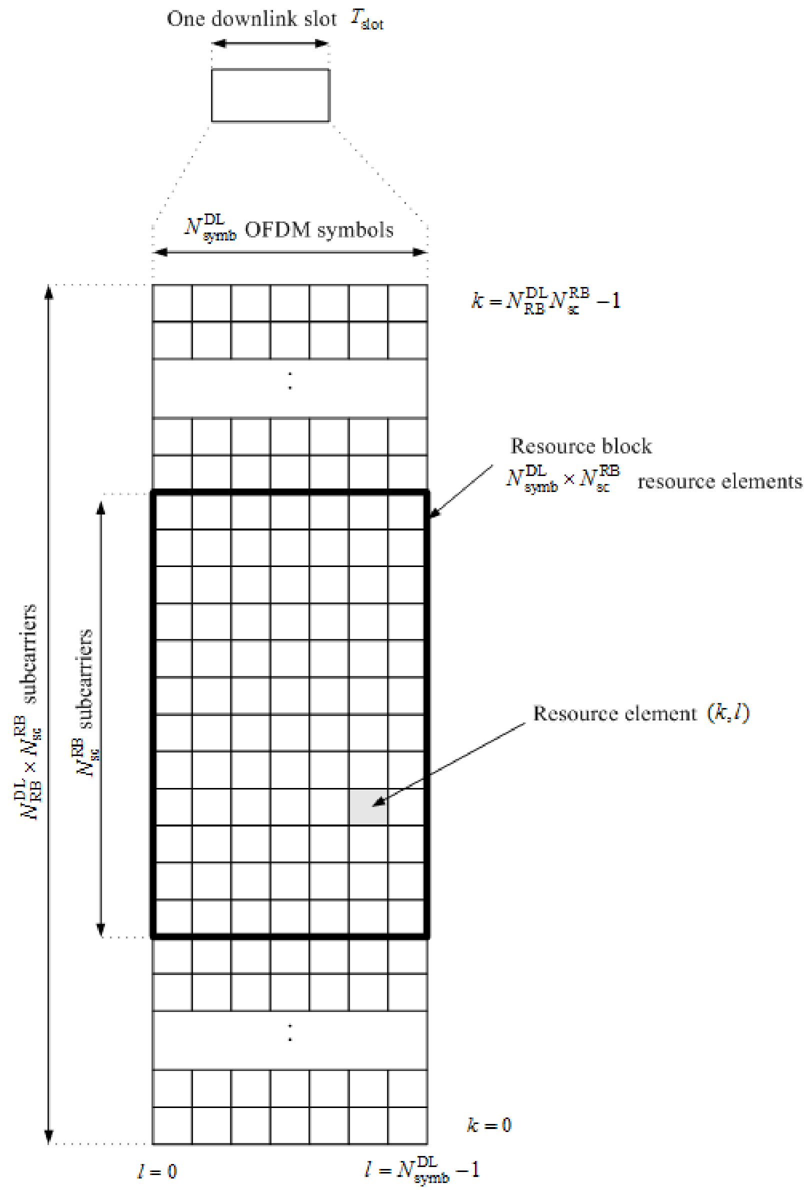


Figure 6.2.2-1: Downlink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 45-46.

	Resource-element groups are used for defining the mapping of the PDCCH to resource elements. **6.2.4 Resource-element groups** Resource-element groups are used for defining the mapping of control channels to resource elements. A resource-element group is represented by the index pair (k',l') of the resource element with the lowest index k in the group with all resource elements in the group having the same value of l. The set of resource elements (k,l) in a resource-element group depends on the number of cell-specific reference signals configured as described below with $k_0 = n_{\mathrm{PRB}} \cdot N_{\mathrm{sc}}^{\mathrm{RB}}$, $0 \le n_{\mathrm{PRB}} < N_{\mathrm{RB}}^{\mathrm{DL}}$. *See e.g.*, 3GPP TS 36.211 V8.9.0 at pg. 48. A PDCCH is an aggregation of CCEs. Each CCE corresponds to 9 resource element groups that map the PDCCH to resource element that define a segment of time-frequency resource. **6.8 Physical downlink control channel** **6.8.1 PDCCH formats** The physical downlink control channel carries scheduling assignments and other control information. A physical control channel is transmitted on an aggregation of one or several consecutive control channel elements (CCEs), where a control channel element corresponds to 9 resource element groups. The number of resource-element groups not assigned to PCFICH or PHICH is N_{REG}. The CCEs available in the system are numbered from 0 and $N_{CCE} - 1$, where $N_{CCE} = \lfloor N_{REG} / 9 \rfloor$. The PDCCH supports multiple formats as listed in Table 6.8.1-1. A PDCCH consisting of n consecutive CCEs may only start on a CCE fulfilling $i \bmod n = 0$, where i is the CCE number. Multiple PDCCHs can be transmitted in a subframe. *See e.g.*, 3GPP TS 36.211 V8.9.0 at pg. 58.

U.S. Patent No. 10,447,450: Claim 7(d)
"the segment having a starting time-frequency coordinate"

the segment having a starting time-frequency coordinate	The segment over which the signal containing information from the base station is received by Toyota's Accused Products has a starting time-frequency coordinate. *E.g.*, The PDCCH has a starting time-frequency coordinate. It starts at a CCE fulfilling i mod $n = 0$, where i is the CCE number. The CCE corresponds to resource element groups which map CCEs to resource elements, which are uniquely identified by a time-frequency index pair. **6.8 Physical downlink control channel** **6.8.1 PDCCH formats** The physical downlink control channel carries scheduling assignments and other control information. A physical control channel is transmitted on an aggregation of one or several consecutive control channel elements (CCEs), where a control channel element corresponds to 9 resource element groups. The number of resource-element groups not assigned to PCFICH or PHICH is N_{REG}. The CCEs available in the system are numbered from 0 and $N_{CCE}-1$, where $N_{CCE}=\lfloor N_{REG}/9 \rfloor$. The PDCCH supports multiple formats as listed in Table 6.8.1-1. A PDCCH consisting of n consecutive CCEs may only start on a CCE fulfilling $i \bmod n = 0$, where i is the CCE number. Multiple PDCCHs can be transmitted in a subframe. *See e.g.*, 3GPP TS 36.211 V8.9.0 at pg. 58. **6.2.4 Resource-element groups** Resource-element groups are used for defining the mapping of control channels to resource elements. A resource-element group is represented by the index pair (k',l') of the resource element with the lowest index k in the group with all resource elements in the group having the same value of l. The set of resource elements (k,l) in a resource-element group depends on the number of cell-specific reference signals configured as described below with $k_0 = n_{\mathrm{PRB}} \cdot N_{\mathrm{sc}}^{\mathrm{RB}}$, $0 \le n_{\mathrm{PRB}} < N_{\mathrm{RB}}^{\mathrm{DL}}$. *See e.g.*, 3GPP TS 36.211 V8.9.0 at pg. 48. The PDCCH is located in the first n OFDM symbols, starting at the first symbol.

U.S. Patent No. 10,447,450: Claim 7(d)
"the segment having a starting time-frequency coordinate"

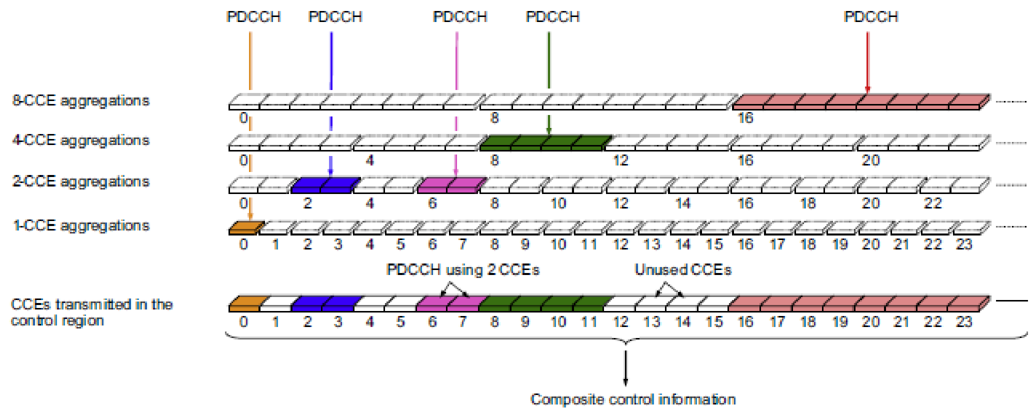
	5.1.3 Physical downlink control channel The downlink control signalling (PDCCH) is located in the first n OFDM symbols where $n \le 4$ and consists of: *See e.g.*, 3GPP TS 36.300 V8.12.0 at pg. 26.

U.S. Patent No. 10,447,450: Claim 7(e)
"the segment comprising N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8; and"

<table>
<tr>
<td>the segment comprising N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8; and</td>
<td>
The segment over which the signal containing information from the base station is received by Toyota's Accused Products comprises N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8. E.g.,
The PDCCH comprises 2 CCEs for a PDCCH format 1, 4 CCEs for a PDCCH format 2, and 8 CCEs for a PDCCH format 3. The PDCCH comprises 2, 4, or 8 CCEs depending on the aggregation level.
<h2>6.8 Physical downlink control channel</h2>
<h3>6.8.1 PDCCH formats</h3>
The physical downlink control channel carries scheduling assignments and other control information. A physical control channel is transmitted on an aggregation of one or several consecutive control channel elements (CCEs), where a control channel element corresponds to 9 resource element groups. The number of resource-element groups not assigned to PCFICH or PHICH is N_{REG}. The CCEs available in the system are numbered from 0 and $N_{CCE}-1$, where $N_{CCE} = \lfloor N_{REG}/9 \rfloor$. The PDCCH supports multiple formats as listed in Table 6.8.1-1. A PDCCH consisting of n consecutive CCEs may only start on a CCE fulfilling $i \bmod n = 0$, where i is the CCE number.
Multiple PDCCHs can be transmitted in a subframe.
Table 6.8.1-1: Supported PDCCH formats
<table>
<tr><th>PDCCH format</th><th>Number of CCEs</th><th>Number of resource-element groups</th><th>Number of PDCCH bits</th></tr>
<tr><td>0</td><td>1</td><td>9</td><td>72</td></tr>
<tr><td>1</td><td>2</td><td>18</td><td>144</td></tr>
<tr><td>2</td><td>4</td><td>36</td><td>288</td></tr>
<tr><td>3</td><td>8</td><td>72</td><td>576</td></tr>
</table>
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 58.
Each CCE is a set of 36 resource elements, which are a set of frequency subcarriers in a group of OFDM symbols.
</td>
</tr>
</table>

U.S. Patent No. 10,447,450: Claim 7(e)

"the segment comprising N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8; and"

	To allow for simple yet efficient processing of the control channels in the device, the mapping of PDCCHs to resource elements is subject to a certain structure. This structure is based on so-called *control-channel elements* (CCEs), which in essence is a convenient name for a set of 36 useful resource elements (nine resource-element groups as defined in Section 6.4.1). The number of CCEs, one, two, four, or eight, required for a certain PDCCH depends on the payload size of the control information (DCI payload) and the channel-coding rate. This is used to realize link adaptation for the PDCCH; if the channel conditions for the device to which the PDCCH is intended are disadvantageous, a larger number of CCEs needs to be used compared to the case of advantageous channel conditions. The number of CCEs used for a PDCCH is also referred to as the aggregation level. The number of CCEs available for PDCCHs depends on the size of the control region, the cell bandwidth, the number of downlink antenna ports, and the amount of resources occupied by PHICH. The size of the control region can vary dynamically from subframe to subframe as indicated by the PCFICH, whereas the other quantities are semi-statically configured. The CCEs available for PDCCH transmission can be numbered from zero and upward, as illustrated in Figure 6.26. A specific PDCCH can thus be identified by the numbers of the corresponding CCEs in the control region. As the number of CCEs for each of the PDCCHs may vary and is not signaled, the device has to blindly determine the number of CCEs used for the PDCCH it is addressed upon. To reduce the complexity of this process somewhat, certain restrictions on the aggregation of contiguous CCEs have been specified. For example, an aggregation of eight CCEs can only start on CCE numbers evenly divisible by 8, as illustrated in Figure 6.26. The same principle  **FIGURE 6.26** CCE aggregation and PDCCH multiplexing. is applied to the other aggregation levels. Furthermore, some combinations of DCI formats and CCE aggregations that result in excessively high channel-coding rates are not supported.

U.S. Patent No. 10,447,450: Claim 7(e)
"the segment comprising N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8; and"

See e.g., 4G LTE-Advanced Pro and The Road to 5G, Third Edition, Dahlman et al.. at pgs. 141-142.

The PDCCH is received during the control region of a subframe which is the initial time interval of the subframe. The number of OFDM symbols constituting this region, or the duration of the time interval, is signalled on the Physical Control Format Indicator Channel (PCFICH). The time interval of the control region can be 1-4 OFDM symbols in length, but typically is 1-3 OFDM symbols in length.

6.7 Physical control format indicator channel

The physical control format indicator channel carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe. The set of OFDM symbols possible to use for PDCCH in a subframe is given by Table 6.7-1.

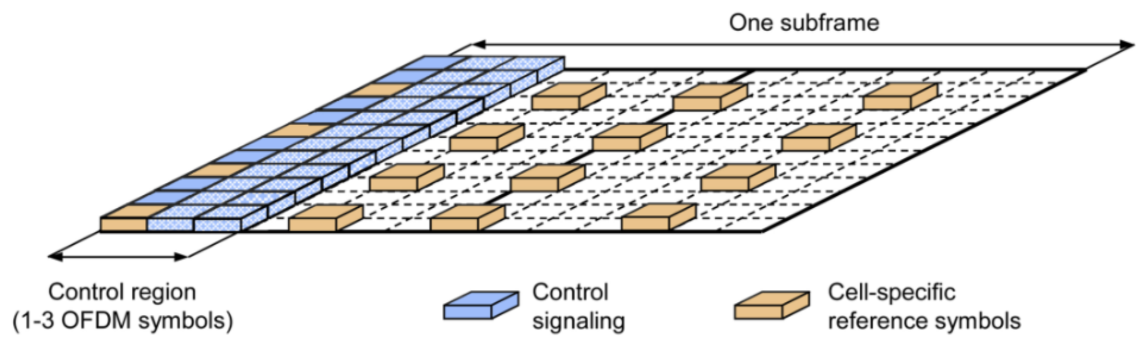
Table 6.7-1: Number of OFDM symbols used for PDCCH.

Subframe	Number of OFDM symbols for PDCCH when $N_{RB}^{DL} > 10$	Number of OFDM symbols for PDCCH when $N_{RB}^{DL} \leq 10$
Subframe 1 and 6 for frame structure type 2	1, 2	2
MBSFN subframes on a carrier supporting both PMCH and PDSCH for 1 or 2 cell specificc antenna ports	1, 2	2
MBSFN subframes on a carrier supporting both PMCH and PDSCH for 4 cell specific antenna ports	2	2
MBSFN subframes on a carrier not supporting PDSCH	0	0
All other cases	1, 2, 3	2, 3, 4

The PCFICH shall be transmitted when the number of OFDM symbols for PDCCH is greater than zero.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 58.

U.S. Patent No. 10,447,450: Claim 7(e)
"the segment comprising N time-frequency resource units within a time interval, each unit containing a set of frequency subcarriers in a group of OFDM symbols, where N=2, 4, or 8; and"

	The basic time–frequency structure for transmission of L1/L2 control signaling is illustrated in Figure 6.20 with control signaling being located at the beginning of each subframe and spanning the full downlink carrier bandwidth. Each subframe can therefore be said to be divided into a control region followed by a data region, where the control region corresponds to the part of the subframe in which the L1/L2 control signaling is transmitted. Starting from release 11, there is also a possibility to locate parts of the L1/L2 control signaling in the data region as described later. However, the split of a subframe into a control region and a data region still applies.  Figure 6.20 LTE time–frequency grid illustrating the split of the subframe into (variable-sized) control and data regions. To simplify the overall design, the control region always occupies an integer number of OFDM symbols, more specifically one, two, or three OFDM symbols (for narrow cell bandwidths, 10 resource blocks or less, the control region consists of two, three, or four OFDM symbols to allow for a sufficient amount of control signaling). The size of the control region expressed in number of OFDM symbols, or, equivalently, the start of the data region, can be dynamically varied on a per-subframe basis. Thus, the amount of radio resources used for control signaling can be dynamically adjusted to match the instantaneous traffic situation. For a small number of users being scheduled in a subframe, the required amount of control signaling is small and a larger part of the subframe can be used for data transmission (larger data region). The maximum size of the control region is normally three OFDM symbols (four in the case of narrow cell bandwidths), as mentioned in the preceding paragraphs. However, there are a few exceptions to this rule. When operating in TDD mode, the control region in subframes one and six is restricted to at most two OFDM symbols since, for TDD, the primary synchronization signal (see Chapter 11) occupies the third OFDM symbol in those subframes. Similarly, for MBSFN subframes (see Chapter 5), the control region is restricted to a maximum of two OFDM symbols. *See e.g.*, 4G LTE-Advanced Pro and The Road to 5G, Third Edition, Dahlman et al.. Section 6.4 Downlink L1/L2 Control Signaling.

U.S. Patent No. 10,447,450: Claim 7(f)
"recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier."

<table>
<tr>
<td>recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier.</td>
<td>
Toyota's Accused Products also recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier. E.g.,
The PDCCH is recovered by the UE using the first OFDM symbol of the first n OFDM symbols and subcarriers corresponding to the resource elements mapped to the CCEs of the PDCCH. The UE uses N, the number of CCEs, to receive the full PDCCH in the supported PDCCH format.
<h3>5.1.3 Physical downlink control channel</h3>
The downlink control signalling (PDCCH) is located in the first n OFDM symbols where $n \le 4$ and consists of:
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 26.
<h2>6.8 Physical downlink control channel</h2>
<h3>6.8.1 PDCCH formats</h3>
The physical downlink control channel carries scheduling assignments and other control information. A physical control channel is transmitted on an aggregation of one or several consecutive control channel elements (CCEs), where a control channel element corresponds to 9 resource element groups. The number of resource-element groups not assigned to PCFICH or PHICH is N_{REG}. The CCEs available in the system are numbered from 0 and $N_{CCE} - 1$, where $N_{CCE} = \lfloor N_{REG} / 9 \rfloor$. The PDCCH supports multiple formats as listed in Table 6.8.1-1. A PDCCH consisting of n consecutive CCEs may only start on a CCE fulfilling $i \bmod n = 0$, where i is the CCE number.
Multiple PDCCHs can be transmitted in a subframe.
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</table>
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 58.
The UE also uses the RNTI to recover the PDCCH.
</td>
</tr>
</table>

U.S. Patent No. 10,447,450: Claim 7(f)
"recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier."

<table>
<tr>
<td></td>
<td>

9.1.1 PDCCH Assignment Procedure

The control region consists of a set of CCEs, numbered from 0 to $N_{\mathrm{CCE},k}-1$ according to Section 6.8.2 in [3], where $N_{\mathrm{CCE},k}$ is the total number of CCEs in the control region of subframe k. The UE shall monitor a set of PDCCH candidates for control information in every non-DRX subframe, where monitoring implies attempting to decode each of the PDCCHs in the set according to all the monitored DCI formats.

The set of PDCCH candidates to monitor are defined in terms of search spaces, where a search space $S_k^{(L)}$ at aggregation level $L \in \{1,2,4,8\}$ is defined by a set of PDCCH candidates. The CCEs corresponding to PDCCH candidate m of the search space $S_k^{(L)}$ are given by

$$L \cdot \left\{ \left(Y_k + m \right) \bmod \left\lfloor N_{\mathrm{CCE},k} / L \right\rfloor \right\} + i$$

where Y_k is defined below, $i = 0, \cdots, L-1$ and $m = 0, \cdots, M^{(L)}-1$. $M^{(L)}$ is the number of PDCCH candidates to monitor in the given search space.

The UE shall monitor one common search space at each of the aggregation levels 4 and 8 and one UE-specific search space at each of the aggregation levels 1, 2, 4, 8. The common and UE-specific search spaces may overlap.

The aggregation levels defining the search spaces are listed in Table 9.1.1-1. The DCI formats that the UE shall monitor depend on the configured transmission mode as defined in Section 7.1.

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U.S. Patent No. 10,447,450: Claim 7(f)
"recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier."

Table 9.1.1-1: PDCCH candidates monitored by a UE.

Type	Search space $S_k^{(L)}$: Aggregation level L	Search space $S_k^{(L)}$: Size [in CCEs]	Number of PDCCH candidates $M^{(L)}$
UE-specific	1	6	6
	2	12	6
	4	8	2
	8	16	2
Common	4	16	4
	8	16	2

For the common search spaces, Y_k is set to 0 for the two aggregation levels $L=4$ and $L=8$.

For the UE-specific search space $S_k^{(L)}$ at aggregation level L, the variable Y_k is defined by

$$Y_k = (A \cdot Y_{k-1}) \bmod D$$

where $Y_{-1} = n_{\mathrm{RNTI}} \neq 0$, $A = 39827$, $D = 65537$ and $k = \lfloor n_s/2 \rfloor$, n_s is the slot number within a radio frame.. The RNTI value used for n_{RNTI} is defined in section 7.1 in downlink and section 8 in uplink.

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 63-64.